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PROCESS MODELS IN E-LEARNING – BOTTOM-UP OR TOP-DOWN?

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ABSTRACT

In the paper, different approaches of process modelling in e-learning system development are investigated. We provide a look at the DIN PAS 1032-1 and in the process model ROME, which is a derivation of the DIN PAS 1032-1. ROME has been extended by several pattern approaches. However, after several years of using ROME, we found out that ROME has some major flaws, which can be traced back to the so-called top-down approach. In ROME, the decision for a certain type of e-learning system is the first step. After this, the process model is used to structure the development process. In reality, in most cases a bottom-up approach would be better suited: centred around the learner and focused on the learner's needs, a content reduction and development should take place, and later, as second level step in the process, a decision for a certain e-learning type can take place.

KEYWORDS

Process Models, Patterns, Agile Software Engineering

1. INTRODUCTION

Coming from the perspective of Computer Science, the domain of e-learning system development is special with regards to the combination of stakeholders involved. Like in no other domain, the resulting system is depending on how well persons with multidisciplinary backgrounds work together. An optimal team of e-learning system developers consists of the psychologist, providing the learning theory background and the empirical design, the computer scientist, who is responsible for the system implementation and the system architecture, the expert of the application domain, who is responsible for the content development, and who has to work hand in hand with the didactic expert, who helps to structure the content in a way that it is optimized for learning. The designer is responsible for a human computer interface, which is best suited for the target group of learners and for representing the content. And last but not least the learner, who is often ignored in the context of e-learning system development, but who plays an important role as target group and as beta tester of a learning software. This optimal team can be seen in figure 1, but can be called pure fiction, when it comes to e-learning system development. Most of the systems are developed either as research artifacts, which focus on special domains (which can be either computer science domains, when a new technology shall be tested (e.g. (Martens, Himmelspach, 2005)), or in application domains, e.g. psychology (Anderson, 1990)), or as pseudo constructs, when an institution decides that now is the time of e-learning. In both cases, the main stakeholder which is the user of the resulting system, i.e. the learner, is completely ignored in the process. From the perspective of computer science, e-learning system development usually still means to re-invent the wheel, as usually no process models are used (even if they exist since the early 2000s, see e.g. (Harrer, 2003), (Harrer, Martens, 2007), (Martens, 2009), (Pawlowski, 2000)). Things go even worse, if such an e-learning system is evaluated. Most of the time, evaluation methods are used on a very coarse level, chosen investigation periods are too short, no comparable group is given, or the group investigated is much too small.

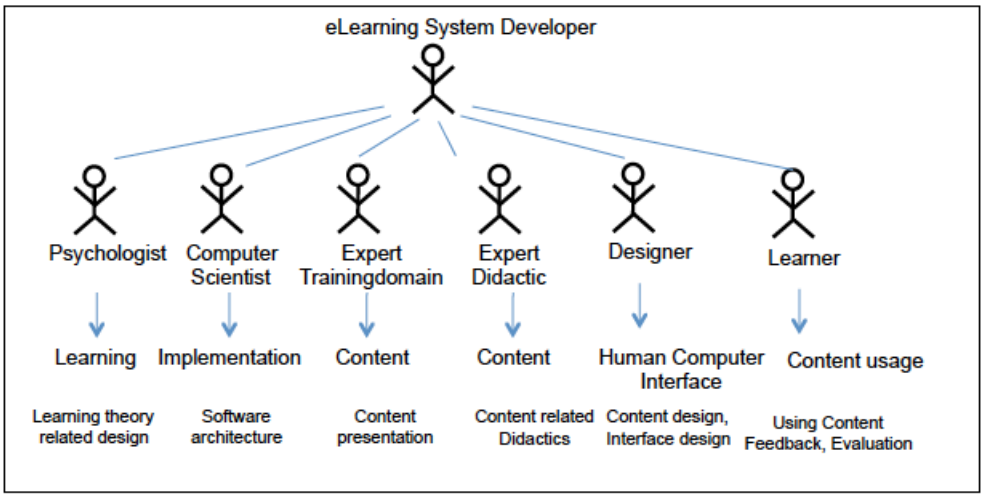

Figure 1. Optimal team of e-learning System developers

With our strong background in instructional sciences, we also have another problem with the state of the art in e-learning system development. In instructional settings, the decision process usually has to start with a focus on the learner (whom shall learn?), shifts to the content (what shall be learned?). The content then is reduced to a level, which meets the learner's needs (in Germany this is called didactical reduction), is then embedded and realized in special purpose methodologies (for education). After all these aspects have been taken into account, the decision regarding the multimedia realizations can take place, e.g. using an e-learning system. We call this the bottom-up approach, due to the fact that the learning itself shall be the basis of all e-learning development, as we perceive e-learning as one of many support technologies to facilitate learning. However, over the last years we have observed in most cases a so called top-down approach, which starts with the e-learning system, then looks for an appropriate content development and, last but not least, looks at the learner. This might be due to the fact that historical e-learning development took exactly this direction (Lelouche, 1999). However, this can no longer be the state of the art.

The reminder of the paper is structured as follows:

In the following section, we give a summary of the existing DIN PAS and ISO/IEC standards in the research area of e-learning, as this is the basis of our development. Several years ago, 2006 to 2009, we have worked with and extended ROME (Rostocker Model for systematic description of e-learning development), which has been developed in the Rostocker Fraunhofer Research Center by Hambach (Hambach, 2008). ROME is an extension of the DIN PAS, and has been brought to another level by integrating software patterns and the idea of boundary objects. This approach has been recently revisited, as we made the experience that even more patterns are usable and that our combined approach has some drawbacks. In the conclusion and outlook, we show some additional point for additional work and we sketch our current field of research, where we are working to bring agile software methods into process model development for e-learning systems.

2. PROCESS MODELS IN E-LEARNING

Process models are used a part of software engineering since several years, at least since the early 1990s (see for example (Gamma, 1995)). In most cases, these process models have been developed as part of knowledge management in multidisciplinary teams, to facilitate communication and to work as boundary objects (see e.g. (Martens, 2009)). The general process management models are independent of the context and they are applicable to all types of software development projects. However, from the perspective of special applications, like for example e-learning, a general process management tool is not easy to use and must be adapted to the special team. For example, the aspects instructional design and the empirical design are special for e-learning systems and cannot be compared to other system types.

As process models for e-learning combine multiple perspectives, which in contrast to the classical software developer – customer scenario require communication on different professional levels, it seems that a new and special purpose process model is required. Several years ago, this led to the development of the system ROME. Since ROME extends the DIN Pas 1032-1 (DIN, 2006), we have taken this as the starting point for our current research.

2.1 DIN PAS and ISO/IEC

To have a foundation to understand the ROME approach, it is necessary to take a look at the different existing standards for a structured development of e-learning proposals. Therefore it is also meaningful to consider the chronology of the German and the international development of the different standards. The German Institute for Standardization (DIN) published in 2004 the DIN PAS 1032-1 "Learning, Education and Training focussing in e-learning" (DIN, 2004). This PAS (Publicly Available Specification) includes a reference model for e-learning proposals for all processes of quality, development, implementation and evaluation. So the DIN PAS 1032-1 gives the team leader a scheme, on which he can rely during the developing, and different use cases. But this reference model is merely focused on the development of e-learning systems and the process structure, coming from a comparably technical perspective. Beyond the decision for an e-learning system is made before the learning objectives and the learners needs were analysed. Thus, the standard cannot be directly transferred to other learning processes and methods, i.e. talks between teacher and learner in the classroom.

After this DIN PAS has been introduced, different other standards were developed. The PAS 1068 (published in 2006) includes a directly description scheme with the motivation, that different e-learning systems could be compared by the components of this scheme (Arnold, 2013). The PAS 1069 (published in 2009) could be understood as a handbook or another reference model for DIN PAS 1032-1 and works, also as the DIN PAS 1032-1, with different examples. As the named standards focus the e-learning system development with a good quality management, the PAS 1037 (it's named in this paper to complete the German standards focussing on e-learning) foregrounds the quality management and introduces therefore a phase model. The PAS 1037 specifies the communication during the process priority.

All in all the different standards show, that they are a support for the planner of e-learning system developments. As the first standard, the DIN PAS 1032-1, describes the structured developing process, the other standards are more or less supplements with examples and concretizations.

Simultaneous to the first DIN standard in Germany, the first international standard for e-learning concepts has been published in 2005. The ISO/IEC 19796:1 describes a process model for the conception of e-learning systems in reference to the DIN PAS 1032-1. The ISO standard has been extended in 2009 by the ISO/IEC 19796:3, which completes the ISO/IEC19796:1 by a process model that includes different methods.

There is also a standard, the so called ISO 9000, which, as does the PAS 1037, focuses the quality management and looks secondary to the development of e-learning proposals. There are also some papers, which describe the adaption of the ISO/IEC 19796:1 for educational organizations (see e.g. (Pawlowski, 2007).

Obviously, all these standards follow the top-down approach, as sketched in the Introduction. This explains the publications, transferring the models on the field of education – like the QAM (Quality adaption model (Pawlowski, 2007) or ROME (Hambach, 2006). The standards are all starting with the e-learning systems and look for a structure or scheme for the development and for an appropriate content development. The learner as main stakeholder in the e-learning system development process and the multimedia decision – whether we need an e-learning system in the educational process or not – are not discussed. This chronological order has to be rearranged. We derived the demand for a model that works bottom-up and will not be obsolete, when the planner decides not to use e-learning units.

2.2 ROME

ROME is based on the DIN PAS 1032-1, but extends the model by a detailed process description and a detailed analysis of phases, tools, roles and artefacts. We will not describe ROME in detail in this paper, but give a short overview. As ROME has the same major drawback (the top-down approach), we sketch our critique in the following section.

As shown in figure 2 on the left hand side, ROME follows the phases: analysis, overall concept development, detailed concept development, production, introduction and teaching/learning. The distinction of overall concept and detailed concept is one difference to the DIN PAS 1032-1. Each of the phases is separated in different steps, which can be seen on the right hand side of figure 2. In the figure, due to graphical readability, we have not noted that the sub-steps of each phase might take place in a different order or even partly in parallel. Moreover, at the end of each phase, the step manage and evaluate allows for a spiral like re-engineering of the sequence of steps. Each of the steps has an associated list of roles, which show the responsibility to plan and execute this step. This is an important tool for the project management leader, who can use this to structure his team. Each of the steps results in artefacts, which can for example be documents, programming parts, data bases or other parts of an e-learning system. In addition to the process and step description in figure 2, ROME contains an elaborate role model, where several roles in the e-learning system design process are sketched, and an extensive resource model, where a list of potential resulting artefacts, their structure and their role in the whole process is given.

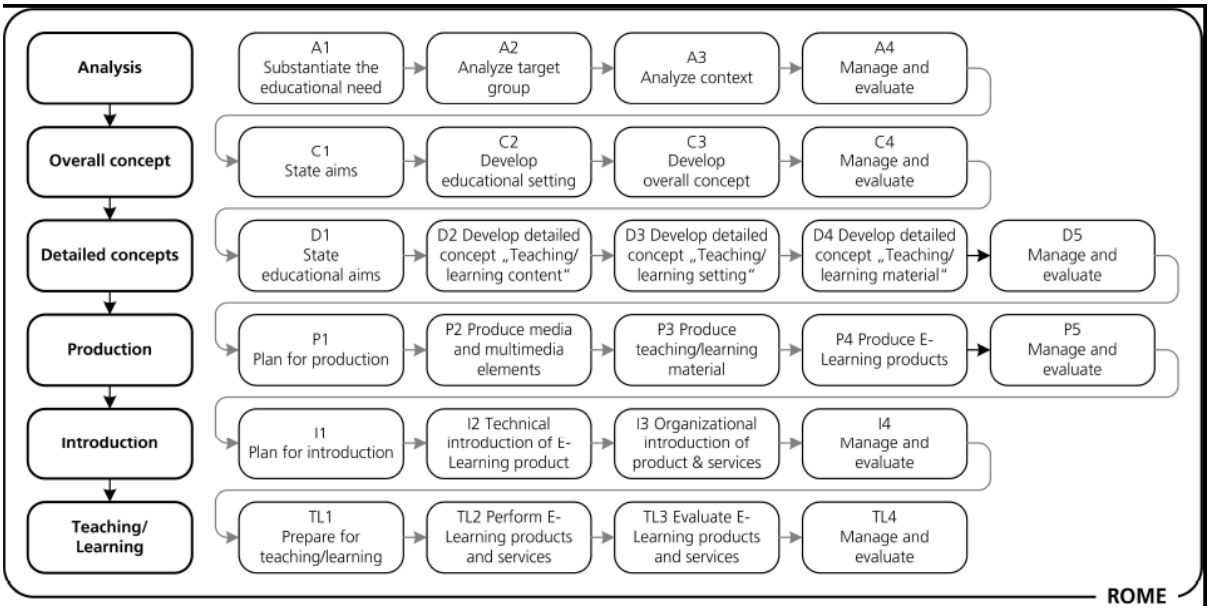

Figure 2. ROME process model for e-learning System development (Hambach, 2008)

In later works, ROME has been extended at different levels. For example, Harrer and Martens have developed a generic pattern language, which has its roots in intelligent tutoring systems and has later been refined and extended towards game-based learning and general e-learning systems (see e.g. (Harrer, 2007), (Maciuszek, 2011)).

From our perspective, ROME as a process model has become mid-level pattern, which is used as intermediate between other patterns, as can be seen in figure 3.

The top level pattern would be given by knowledge management patterns. In the context of multidisciplinary teams, these are usually communication management and time management techniques. One technique, which we like to use as kick off in e-learning project development, is the World Café method, which can be used to structure conversational processes. In addition we want to focus on the participation of all involved during the development process to consider various requirements of the stakeholders.

The related low level patterns are used by the computer scientists and designers in the team, and they are directly related to software development patterns (Gamma, 1995). We have also worked with task models and with content patterns from story design (Maciuszek, 2011), which are low level patterns for non-computer scientists, like for example story authors in role playing games.

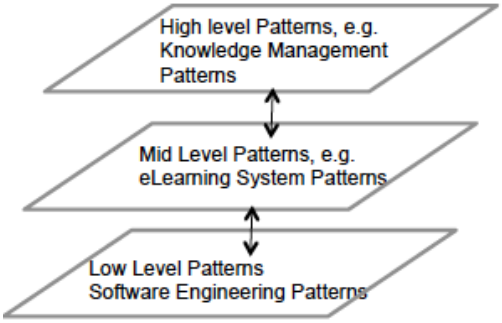

Figure 3. Levels of Patterns in Process Modelling

3. RE-ENGINEERING ROME

After using ROME for several years now, we have experienced the following drawbacks: even if ROME allows interpreting some steps as responsible for the instructional design (e.g. step C2 and D2 have been used for this purpose), an explicit integration of instructional design (or didactical design, as we prefer to call it in Germany) is necessary. Accordingly, after integrating instructional design, the design process as a whole is not any longer correct. If we are thinking in terms of instructional design, the decision for certain content and the reduction of this content to the educational purpose is missing as prior decisions. Thus, the process sequence analysis - concept - production is not valid any more. In ROME, a classical top-down approach is used, where the first step is to decide that an e-learning system shall be developed. The look at the person in the centre, the learner, is taking place comparably late in the process (see figure 2), after the educational setting is analysed.

In our bottom up approach, we use the sequence learner analysis, content analysis, content reduction, instructional concept, technical concept, evaluation concept and production. Moreover, also these phases can be re-visited in a spiral manner. We suggest starting with a specification of the target group (who is the learner and where should he learn?), followed by the analysis of the content (what shall be learned?). A very important step in this context, and flaw of quite a lot teaching and training approaches, is the missing instructional reduction of the content. This means that the content itself is not adapted to the target group, to the prior knowledge of the target group, to the cognitive level (or the assumed level), etc. After the reduction of the content took place, the instructional methods used for re-structuring the content in an instructionally adequate way must be chosen and the design of the content can happen. This, again, has to take the learner into account. Additionally, information about the learning setting must influence this design. After all these analysis and design steps took place, the decision about the e-learning system itself can be performed. A decision here can for example mean to decide for a certain form of e-learning (e.g. intelligent tutoring, game-based learning, simulation, etc). After that, the communicative process about how to bring content and computer system together can take place. However, at this point of development, this is mainly a technical, or software engineering decision.

Interesting in our approach is also the fact, that the usage of e-learning can be completely excluded: the design of an instructional learner centred process can lead to the decision to explicitly not use a computer in the teaching and training of certain content. Naturally, this is quire depressing for e-learning system developers, as we are, but we think that the idea to open up to this direction helps us to develop really useful and usable e-learning systems.

The next aspect, which is completely missing in ROME, is the design of the evaluation of the e-learning systems. In the last years, we found out, that so called empirical evaluation of e-learning is in most cases only on a very bad level: usually, hypotheses are missing; in most cases, the compared groups are not comparable, as instructional design varies between computer based and non-computer based setting; and in most cases, the evaluation is only used as a vehicle for justification of just another e-learning system.

Although another aspect is the knowledge management during the development. Different management techniques that focusses on participation of all involved stakeholders and quality management should not be excluded.

4. CONCLUSION AND OUTLOOK

Most of the e-learning systems, which can be found in research and even in commercial settings, are developed off scratch. This is surprising, as e-learning system development comes with comparably high costs, is very time consuming, and, on the other hand, lends itself for structured approaches. Moreover, diverse structured approaches exist since the early 2000s. As a small overview over the diverse approaches, we have focused in this paper our own work, which has started from the DIN PAS 1032-1, refined this towards the ROME model, which has been used as centre point for multi-level pattern developments. We have sketched these approaches in the section 2. However, after several years of using ROME, we found out, that our approach has some major drawbacks. Thus, we have decided to re-design ROME.

As ROME starts with the idea to develop an e-learning system and then takes into account learners and content (which is called top-down approach in this paper), we have decided to start at the roots: as the learner is the centre of each learning process, we develop a bottom-up approach, which is based on an analysis of the learner, and analysis and reduction of the content and an adaptation of the content to the learner.

Our current revision process of the process model ROME and the related patterns lead us to the idea to combine this with agile software development methods.

In order to adopt the idea and the principals of agile software development for learning processes, we will discuss the fundamentals of agile software development. Based on the "agile manifest" we accentuate the aspects communication, collaboration and flexibility (Beedle, 2001). These notes illustrate a continuity of feedback polish between all included persons and the possibility to adapt the product or the process during the development.

Remembering on the painted experience of actual developing processes, we could repeat the request of the following description: It is necessary to work hand in hand with the person, who is responsible for the content development, the didactic expert, the designer and the learner.

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